

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
8 July 2004 (08.07.2004)

PCT

(10) International Publication Number  
**WO 2004/056572 A3**

(51) International Patent Classification<sup>7</sup>: **B41J 2/14**

(GB). **DRURY, Paul, Raymond** [GB/GB]; 8 New Road,  
Great Chishill, Royston, Hertfordshire SG8 8ST (GB).

(21) International Application Number:  
PCT/GB2003/005626

(74) Agents: **GARRATT, Peter, Douglas et al.**; Mathys &  
Squire, 100 Gray's Inn Road, London WC1X 8AL (GB).

(22) International Filing Date:  
22 December 2003 (22.12.2003)

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,  
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,  
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,  
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,  
MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC,  
SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA,  
UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
0229655.6 20 December 2002 (20.12.2002) GB

(71) Applicant (*for all designated States except US*): **XAAR  
TECHNOLOGY LIMITED** [GB/GB]; Science Park,  
Cambridge CB4 0XR (GB).

(84) Designated States (*regional*): ARIPO patent (BW, GH,  
GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),  
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,  
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE,  
SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA,  
GN, GQ, GW, ML, MR, NE, SN, TD, TG).

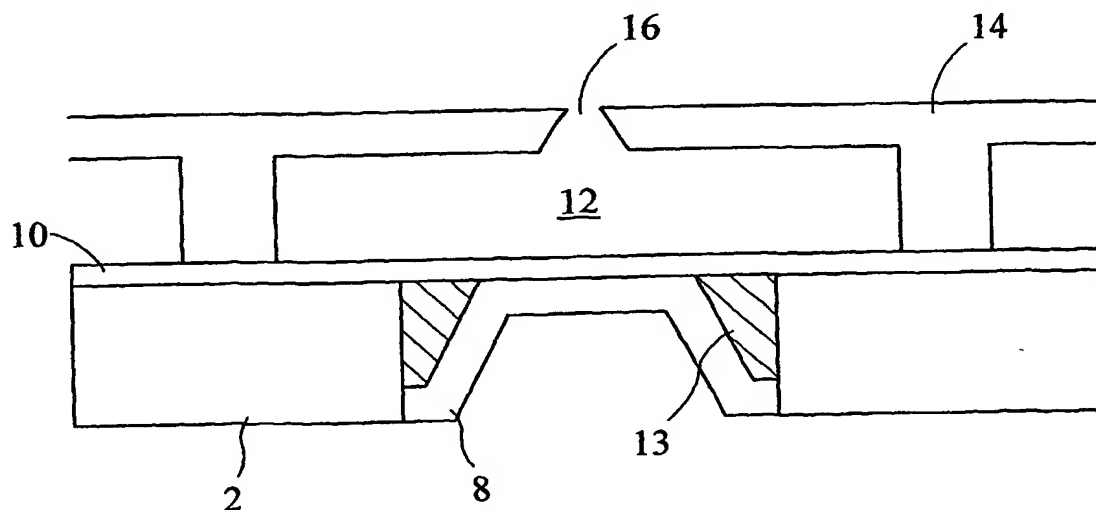
(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **TEMPLE, Stephen**  
[GB/GB]; The Windmill, Impington, Cambridge CB4 9NU  
(GB). **HARVEY, Robert** [GB/GB]; 44 Windsor Road,  
Cambridge CB4 3JN (GB). **LOWE, Robert, Jonathan**  
[GB/GB]; 37 St. Kilda's Avenue, Cambridge CB4 2PN

Published:  
— with international search report

[Continued on next page]

(54) Title: DROPLET DEPOSITION APPARATUS



(57) Abstract: A drop on demand ink jet printer, has a passive component (14) defining ink ejector chambers (12) with respective ejection nozzles (16); and an actuator component comprising a body (2) with an opening and an actuator structure (8) located within the opening. The actuator structure is formed of piezoelectric material by moulding from a slurry or vacuum forming of flexible sheets using formers that are burnt away. MEM's techniques may also be employed to build the structure on a silicon wafer using a succession of masked deposition; etch back and similar process steps.

WO 2004/056572 A3



— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**(88) Date of publication of the international search report:**  
7 October 2004

# INTERNATIONAL SEARCH REPORT

International Application No

PC 1, GB 03/05626

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B41J2/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B41J H01L B81B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, IBM-TDB

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 01/72520 A (SAKAMOTO YOSHIKI ; FUJITSU LTD (JP); KOIKE SHUJI (JP); SHINGAI TOMOHI) 4 October 2001 (2001-10-04) the whole document & US 2003/016273 A1 (SAKAMOTO YOSHIKI ET AL) 23 January 2003 (2003-01-23)	1-5, 10-19
X	WO 01/72519 A (SAKAMOTO YOSHIKI ; FUJITSU LTD (JP); KOIKE SHUJI (JP); SHINGAI TOMOHI) 4 October 2001 (2001-10-04) the whole document & US 2003/025767 A1 (SAKAMOTO YOSHIKI ET AL) 6 February 2003 (2003-02-06)	1-4, 10-19
X	TW 506 908 B (NANODYNAMICS INC) 21 October 2002 (2002-10-21) the whole document -/-	1-3, 11

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

28 July 2004

Date of mailing of the international search report

17 AUG. 2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+31-70) 340-3016

Authorized officer

Van Oorschot, J

# INTERNATIONAL SEARCH REPORT

Int. Application No

PC1/GB 03/05626

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>&amp; US 2003/025767 A1 (CHEN-HUA LIN) 6 February 2003 (2003-02-06)</p> <p>WO 00/16981 A (XAAR TECH LTD ;TEMPLE STEPHEN (GB); HARVEY ROBERT ALAN (GB)) 30 March 2000 (2000-03-30) cited in the application the whole document</p>	
A	<p>EP 0 921 003 A (OCE TECH BV) 9 June 1999 (1999-06-09) column 4 - column 7</p>	6
X	<p>WO 02/078959 A (PHILIP MORRIS PROD) 10 October 2002 (2002-10-10) paragraph '0023! - paragraph '0042!</p>	20-28
X	<p>US 6 428 140 B1 (CRUZ-URIBE ANTONIO S) 6 August 2002 (2002-08-06) column 3 - column 9</p>	20,21,28
X	<p>US 5 459 501 A (LEE STEVEN S ET AL) 17 October 1995 (1995-10-17) column 4, line 58 - column 5, line 33</p>	29-40, 43,44
X	<p>US 2002/130925 A1 (KOEDA HIROSHI) 19 September 2002 (2002-09-19)  paragraph '0034! - paragraph '0056!</p>	29-31, 36,37, 41,42

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/GB 03/05626

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 72,73  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:  
1-44
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

International Application No. PCT/ GB 03/ 05626

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 72,73

Claims 72 and 73 are omnibus claims: these claims do not define any subject matter than by reference to the figures. These claims do not meet the requirements of Art. 6 and Rule 6.2(a) PCT. No search can be performed.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

## INTERNATIONAL SEARCH REPORT

International Application No. PCT/ GB 03/ 05626

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-19

Actuator components as explained in points 1.1 and 1.2 below.

1.1. claims: 1-11,16-19

Actuator component as defined in claim 1, in particular directed to an actuator as defined in claim 1,5,6.

1.2. claims: 1,11,12-15,18,19

Actuator component as defined in claim 1, in particular directed to an actuator as defined in claim 1,11,12

---

2. claims: 20-28

A component for ejecting a droplet in a direction of droplet flight, said component comprising an actuator structure displaceable by actuation in the direction of said droplet flight (cf. part of claim 20):  
in particular directed to said actuator (19,20) defining in part an ejection chamber and comprising a port through which said droplet is ejected.

---

3. claims: 29-44

The method of claim 29 in particular directed to: a) providing a body having a mould feature, b) forming a deformable actuator structure, the shape of said actuator structure being defined, at least in part by said mould feature, c) removing at least a portion of said mould feature.

---

4. claims: 45-62

The method of claim 45 in particular directed to the additional steps of b) forming an opening in said top surface and extending into said body and; c) forming within said opening an actuator structure; said actuator structure remaining attached to said body during actuation.

---

5. claims: 63-71

## INTERNATIONAL SEARCH REPORT

International Application No. PCT/ GB 03/ 05626

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

The channeled component of claim 63 in particular directed to a respective ejection nozzle connected with the channel at a point intermediate its length; a liquid supply providing for continuous flow of liquid along said channel; acoustic boundaries at respective opposite ends of the channel serving to reflect acoustic waves in the liquid of the channel wherein the inter-channel spacing of said acoustic boundaries is different to the inter-channel spacing of said nozzles.

---



# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PC 03/05626

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 0172520	A	04-10-2001	WO 0172520 A1	04-10-2001
			US 2003016273 A1	23-01-2003
US 2003016273	A1	23-01-2003	WO 0172520 A1	04-10-2001
WO 0172519	A	04-10-2001	WO 0172519 A1	04-10-2001
			US 2003025767 A1	06-02-2003
US 2003025767	A1	06-02-2003	WO 0172519 A1	04-10-2001
TW 506908	B	21-10-2002	JP 2003118128 A	23-04-2003
			US 2003043237 A1	06-03-2003
			US 2003184619 A1	02-10-2003
US 2003025767	A1	06-02-2003	WO 0172519 A1	04-10-2001
WO 0016981	A	30-03-2000	AU 761033 B2	29-05-2003
			AU 6212399 A	10-04-2000
			BR 9913998 A	03-07-2001
			CA 2342367 A1	30-03-2000
			CN 1480328 A	10-03-2004
			CN 1135165 B	21-01-2004
			EP 1115577 A1	18-07-2001
			WO 0016981 A1	30-03-2000
			JP 2002526301 T	20-08-2002
			US 6331045 B1	18-12-2001
EP 0921003	A	09-06-1999	EP 0921003 A1	09-06-1999
			JP 11227205 A	24-08-1999
WO 02078959	A	10-10-2002	TW 548198 B	21-08-2003
			WO 02078959 A1	10-10-2002
			US 2002140781 A1	03-10-2002
US 6428140	B1	06-08-2002	NONE	
US 5459501	A	17-10-1995	JP 7001728 A	06-01-1995
			US 5581861 A	10-12-1996
US 2002130925	A1	19-09-2002	WO 9934979 A1	15-07-1999
			JP 3500636 B2	23-02-2004
			US 6425656 B1	30-07-2002